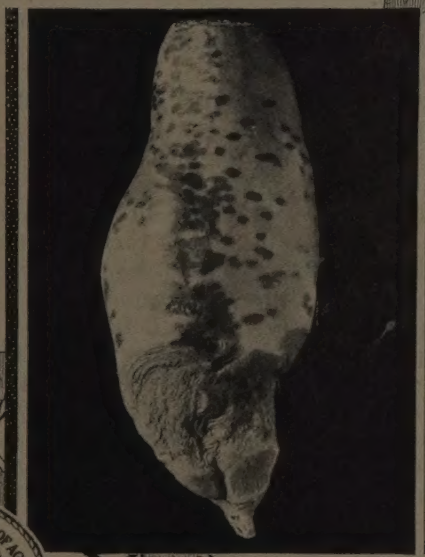
JAN 48

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1059

SWEET-POTATO DISEASES



DISEASES of sweet potatoes are divisible into two classes, (1) field troubles and (2) storage rots. Field troubles are divisible into root and stem diseases and leaf diseases.

Root and stem diseases include stem rot, black rot, foot rot, scurf, root rot, mottle necrosis, and soil rot; and leaf diseases include leaf blight, white rust, and leaf spot. For the control of the three diseases first mentioned, seed selection, the use of clean seed beds, disinfection of the seed potatoes before bedding, and crop rotations are about all that can be recommended, since the fungi causing the diseases invade the interior and make the use of fungicides futile.

Scurf is best controlled by the selection of clean seed and by disinfecting the seed potatoes for 8 minutes in a solution of mercuric chloride (1 ounce to 8 gallons of water).

Root rot is particularly difficult to control. Deep, clean cultivation, aeration of the soil, and crop rotation, together with the careful selection of disease-free potatoes for seed, are important aids.

Leaf blight, leaf spot, and white rust have never been serious enough to require remedial measures.

Control of the five storage rots described hinges on careful storage-house management.

Sweet potatoes infected with field diseases should never be placed in storage, for heavy loss will follow. But this elimination of field diseases must be coupled with a well-regulated system of storage, the first requisite of which is a thoroughly disinfected house free from the numerous storage-rot germs.

This bulletin is a revision of Farmers' Bulletin 714.

Washington, D. C. Issued October, 1919
Revised November, 1928

P.A.B
28 NOV 1947

SWEET-POTATO DISEASES

By L. L. HARTER, *Senior Pathologist, Office of Vegetable and Forage Diseases, Bureau of Plant Industry*

CLASSIFICATION AND DESCRIPTION OF SWEET-POTATO DISEASES

	Page
Field diseases:	
Stem rot (*wilt*). Discoloration of the young leaves and bundles of the stem; wilting of the vines	2
Black rot. Black spots and cankers on the sprouts and circular black spots on the roots	7
Foot rot. Rotting of the stem near the soil, followed by wilting of the plant	8
Scurf. Brownish discoloration or rusting of the skin of the potato, mostly in spots	10
Root rot. A dry, firm rot of potatoes in the field; vines injured for a foot or more from the hill	12
Mottle necrosis. A marbled chocolate-brown discoloration of the interior of the fleshy root	13
Soil rot. Pits of various sizes on the fleshy roots; black cankers on the rootlets	14
Leaf blight. Circular brownish spots on the leaf with many black specks	16
Leaf spot. Small circular spots on the leaf with one or more black spots	17
White rust. A whitish, moldy growth on the under side of the leaf	17
Storage rots:	
Soft rot. Watery decay of roots only	18
Ring rot. Like soft rot, but decay begins between the ends	18
Black rot. Circular, black, somewhat sunken spots on the potatoes, variable in size	19
Dry rot. A firm, dry rot of roots only	20
Java black rot. A firm dry rot of roots only; black within; protuberances on the surface	20
Charcoal rot. A rot of tubers only; black within	21

SWEET POTATOES are subject to diseases in the field and to rots in storage and transit. The former may be divided into root and stem diseases and leaf diseases. Stem rot, black rot, foot rot, scurf, mottle necrosis, soil rot, and root rot affect the stems and roots; leaf blight, leaf spot, and white rust, the foliage. Selection of disease-free seed, disinfection of the seed potatoes in a solution of corrosive sublimate, and deep and thorough cultivation are among the methods of control. Leaf diseases never have been serious enough to require remedial measures.

The storage rots include soft rot, ring rot, black rot, dry rot, Java black rot, and charcoal rot. Losses from these troubles are heavy in storage, but may be reduced considerably by proper storage methods, and may be controlled by careful handling and by storing only sound potatoes in a suitable, thoroughly disinfected house in which proper temperature and humidity are maintained. If this practice is followed, the potatoes may be held until spring, when much higher prices may be obtained than by selling the surplus when the crop is dug. In this bulletin the characteristics of the various diseases in field and storage are given, and control methods are presented so far as known.

FIELD DISEASES

STEM ROT (WILT, BLUE STEM, YELLOW BLIGHT)

DESCRIPTION

The first indication of stem rot in the field is a slight change in the appearance of the youngest leaves, which become duller in color, then yellowed between the veins and somewhat puckered. These symptoms are followed by wilting of the vines and eventually by a collapse and death of the entire plant. (Fig. 1.) The stems and vines of diseased plants are blackened inside. This discoloration sometimes extends 3 to 5 feet from the hill and is a sure sign of stem rot. The organism causing stem rot may also invade the roots, forming a

FIG. 1.—A sweet-potato plant showing the characteristic symptoms of stem rot

blackened ring about a quarter of an inch below the surface of the potato. (Fig. 2.) Sprouts from such potatoes are likely to be diseased.

In the hotbed the symptoms of the disease are similar to those in the field. Diseased plants can generally be detected by the faint purplish tint that is cast through the white part of the stem and by the yellow discoloration of the leaves.

CONTROL OF STEM ROT

FERTILIZERS AND FUNGICIDES INEFFECTIVE

As the fungus causing stem rot invades the interior of the plants, fungicides give no relief. Lime and gypsum applied to the soil are of no value.

IMMUNE AND SUSCEPTIBLE VARIETIES

The following varieties, none of which are entirely immune, can be grown with comparative safety in infested soil: White Yam, Southern Queen, Triumph, Red Brazil, Yellow Strasburg, Key West, and Dahomey. The following varieties are quite susceptible to stem rot or wilt: Yellow Jersey, Big Stem Jersey, Gold Skin, Nancy Hall, Porto Rico, Red Jersey, and Georgia.

SEED SELECTION

The fungus lives over in sweet potatoes in the storage houses and grows from diseased seed potatoes into the plants developed from them. In the early stages these diseased plants are hard to detect, and, in consequence, many of them are set in the field, where the fungus continues to grow. It is, therefore, imperative that only healthy potatoes be used for seed. Healthy seed can be secured by selection in the fall at digging time, while the potatoes are still attached to the vines. Each hill should be tested by splitting the stem, and potatoes for seed should be taken only from plants the insides of whose stems are not streaked with black, though it should be remembered that a heavy frost will also produce a similar appearance. The fall selection of seed is necessary, owing to the fact that in the spring or during the winter it is difficult and frequently impossible to tell whether the potatoes are diseased or not, since after a period in storage the bundles (the tissues traversing the tuber) of healthy potatoes often become somewhat darkened, even though the fungus is not present.

FIG. 2.—Sweet-potato stem rot. A section through a sweet potato, showing the blackened ring just below the surface caused by the stem-rot fungus.

The potatoes selected for seed should be stored in baskets or crates, in a part of the house where they will not come in contact with the general stock.

In the spring just before they are bedded, the seed potatoes should be disinfected by treating them for 8 to 10 minutes in a solution made by dissolving 1 ounce of corrosive sublimate in 8 gallons of water. Only wooden vessels should be used for disinfection. Corrosive sublimate is a strong poison and should be kept out of the reach of animals. This treatment will not kill the stem-rot fungus within the potato, but it will destroy any spores that may be on the surface. After treating about 10 bushels in 24 gallons of solution, one-half ounce of corrosive sublimate dissolved in hot water should be added and the solution made up to the original volume by the addition of water. Repeat the process after the treatment of each 10 bushels

until 30 bushels are treated, then throw away the solution and start with a fresh one. If for any reason corrosive sublimate can not be used, the potatoes may be immersed for 5 minutes in a solution of formaldehyde made by adding 1 pint of commercial formalin to 30 gallons of water.

PREPARATION OF HOTBED

The repeated use of the same soil year after year in the hotbed is probably one of the chief means of distributing many sweet-potato diseases. This soil, after the hotbed season is over, is often either left in the beds or thrown out to one side with all the decayed potatoes and manure. The germs multiply, and if the same soil is used next year the potatoes and plants are at once exposed to infection. Furthermore, when bedding their potatoes, farmers frequently throw the diseased potatoes to one side. These eventually become mixed with the soil, and the disease germs are carried on the shoes and by chickens, etc., to the hotbed. As a result hotbeds which might otherwise produce healthy plants become badly infected.

Soil once used in the hotbed should be hauled away and all the rubbish around the bed raked up and carted off or burned. The framework of the hotbed and the ground around it should be thoroughly soaked with a solution of formaldehyde made by mixing 1 pint of formalin and 30 gallons of water, or if preferred, with a solution of copper sulphate made by dissolving 1 pound of copper sulphate in 25 gallons of water. It is advisable that this treatment be repeated after about 24 hours. The soil for the hotbed, or preferably sand, should be obtained from some place where sweet potatoes have never been grown, if possible from some high spot in the woods. The upper 6 inches of the soil should be thrown away and only subsoil used. Rich soil is not necessary for the hotbed; in fact, some of the best results have been obtained by using pure sand. The farm implements used to handle and haul away the old soil should not be used to handle new soil or sand without being cleaned and disinfected by a solution of formaldehyde. A grade of sand or subsoil should be used that will not bake or form a crust through which the sprouts can not emerge.

In regions where sweet-potato diseases occur, the use of stable manure in the hotbed is a practice of doubtful value, since potatoes discarded or fed to stock find their way too easily to the manure pile. However, stable manure may be safely used if great care is exercised to cook all decayed or diseased potatoes before feeding them to stock and never to throw them out in the yard, where infected parts may be carried around on the feet of poultry and farm animals.

CROP ROTATION

Although healthy plants may be grown by careful seed selection and care in the preparation of the hotbed, the effort is largely wasted if the plants are set in infested soil. It is, therefore, imperative that the plants be set on new ground or ground which has not produced sweet potatoes for several years.

The stem-rot fungus will live in the soil indefinitely, even in the absence of sweet potatoes. For that reason, sweet potatoes should

not be planted on the same ground oftener than once in three or four years. The fungus will not be eradicated, but the losses will be reduced. No other crops are known to be attacked by the stem-rot fungus; therefore, any crops commonly grown in the region may be used in the rotation.

SLIP SEEDING

By slip seeding is understood the practice of cutting up the vines so as to include at least two buds or leaves and inserting one end, usually the larger, into the ground, the potatoes produced therefrom to be used for seed for the next year's crop. The practice of slip seeding is followed generally in some localities and not at all in others. When intelligently done it is an efficacious means of controlling sweet-potato diseases. However, if practiced independently of all sanitary measures it is of little value. The writer has examined quantities of slip-seed stock, both in the field and in storage, and found an abundance of stem rot, black rot, foot rot, and practically all of the diseases present in that particular locality. In regions where the disease germs are not present in all soils beneficial results have been obtained.

Precautions in slip seeding.—To obtain good results from slip seeding the following precautions must be taken:

1. The cuttings should be made from healthy vines. This will seem obvious when it is remembered that the organism causing stem rot often grows out into the vines 4 to 5 feet from the hill and it can not always be detected without pinching open the vine.
2. The cuttings must be planted on new ground or on ground on which sweet potatoes have not been grown for at least six years.
3. The potatoes produced by the cuttings must be picked over and disinfected in the spring before bedding, according to directions already given.
4. The seed potatoes must be bedded in a hotbed prepared according to the directions given above.

DISTRIBUTION, PREVALENCE, AND LOSS

Stem rot occurs in the States of New Jersey, Delaware, Maryland, Virginia, Illinois, Iowa, Kansas, Alabama, California, Arkansas, Missouri, Tennessee, Florida, North Carolina, Ohio, Georgia, Texas, Indiana, Oklahoma, Washington, Colorado, and Mississippi. It probably occurs in other States also.

In New Jersey 10 to 50 per cent of the crop is destroyed by stem rot each year, and fields have been found where 95 per cent of the plants were killed. In New Jersey and Delaware, where the sweet potato forms an important money crop, the losses annually amount to many thousands of dollars. Conditions are equally bad in Iowa, parts of Kansas, and in southern Illinois. In Maryland, Virginia, and Alabama, although the losses are considerable each year, they are relatively less than in New Jersey, Delaware, Iowa, and Kansas. In some of the other States the losses at present are comparatively small. At the most conservative estimate, stem rot is responsible for a loss of at least three-quarters of a million dollars annually to the sweet-potato crop in the United States.

HOW STEM ROT IS DISTRIBUTED

Stem rot will live throughout the winter in the soil on the remains of dead sweet-potato vines and in the potatoes in storage. There-

fore, the distribution of the disease from one field to another in the same locality may be brought about by (1) insects, (2) farm animals that roam from one field to another, (3) farm implements, (4) drainage water, (5) wind, and (6) discarded diseased roots dumped on the fields as fertilizer, either before or after being fed to stock.

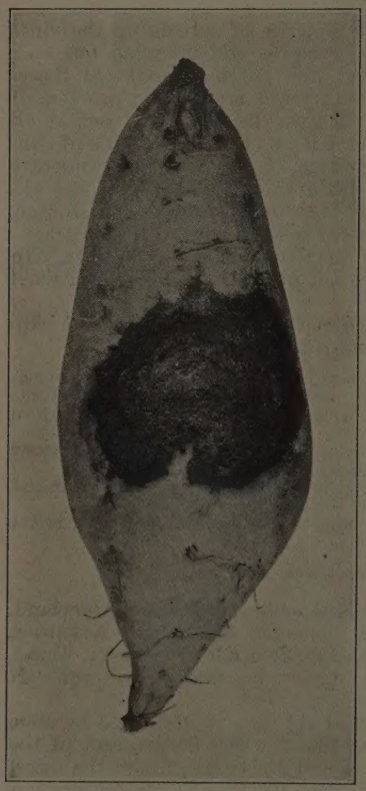


FIG. 3.—Sweet-potato black rot. A sweet potato showing the black circular spot produced by the black-rot fungus. Such spots are somewhat sunken

FIG. 4.—Sweet-potato black rot. A small plant showing the characteristic blackening of the underground part of the stem

The distribution of the disease from one locality to another is brought about primarily by the exchange or sale of seed potatoes and plants. In some cases the appearance of the disease in a locality can be definitely traced to the importation of seed potatoes and plants.

CAUSE OF STEM ROT

Two different fungi or moldlike plant growths, *Fusarium batatatis* and *F. hyperoxysporum*, cause the stem rot of sweet potatoes. These

organisms, like many others of their kind, can live for several years on decayed vegetation in the soil until they again come in contact with the sweet potato.

Infection takes place through the roots, either in the field after the plants are set out or in the hotbed by growing from diseased potatoes into the plants. Such infected plants when set in the field soon die.

The mycelium or vegetative part of the fungus develops rapidly and often enters the root and grows up into the water-carrying vessels of the stem. Following the death of the plant the vines turn black, the fungus living thereafter on the decaying vegetation. On the dead vines numerous fruiting bodies, or spores, are developed. Being very small, the spores are readily carried by the wind, insects, and other agencies to other fields, where new infections may arise.

BLACK ROT (BLACK SHANK, BLACK ROOT)

DESCRIPTION

Black rot may occur on any of the underground parts of the plant. On the sweet potato the fungus produces dark to nearly black, somewhat sunken, more or less circular spots on the surface. (Fig. 3.) In the early stages these spots are small and nearly round, but under favorable conditions they enlarge, until frequently nearly the whole potato is involved. Often in the center of the spots will be seen more or less circular areas, from one-fourth to one-half an inch in diameter, in which may be found fruiting bodies of the fungus. The surface of the diseased spots has a somewhat metallic luster, and the tissue just beneath is greenish.

On the plants the infection begins as small black spots, which gradually enlarge until the whole of the stem is rotted off. Frequently it extends up the stem to the surface of the soil. (Fig. 4.) It is important to remember that if black-rot potatoes are used for seed the plants coming from them will likely have black rot.

All sweet-potato growers are well aware that black-rot sweet potatoes have a very disagreeable taste when cooked. Their sale has a bad effect upon the market, and they may be the means of carrying the disease into an uninfected locality.

CONTROL OF BLACK ROT

No varieties are known to be resistant to black rot.

About the same control methods should be applied to black rot as to stem rot, particularly the preparation of the hotbed, the selection of seed potatoes, and crop rotation. If black rot alone is concerned, the seed may be selected in the spring instead of in the fall; if selected in the fall, it should be picked over again in the spring and any potatoes with suspicious spots on them discarded.

The treatment of the soil with sulphur, lime, gypsum, or different fertilizers has little effect on the disease. Dipping the slips in a solution of Bordeaux mixture or in a lime-sulphur mixture just before setting them in the field does not prevent the disease, but has been found to injure the plants.

DISTRIBUTION, PREVALENCE, AND LOSS

Black rot is known to occur in New Jersey, Delaware, Maryland, Virginia, Ohio, Illinois, Missouri, Iowa, Kansas, Oklahoma, Texas, Arkansas, North Carolina, South Carolina, Georgia, and Alabama, and it is probable that it occurs wherever sweet potatoes are grown.

In all the regions mentioned the disease is prevalent on the plants or slips in the hotbed and on the potatoes in the storage houses in the winter; in fact, heavy losses are caused by this disease in storage houses, where it develops freely under favorable conditions and renders the potatoes unfit for consumption.

HOW BLACK ROT IS DISSEMINATED

In general, black rot is disseminated in about the same way as stem rot. Unlike stem rot, however, black rot spreads freely through the storage house under favorable conditions. Small flies and other insects carry the spores on their bodies from diseased to healthy potatoes, where, if conditions are favorable, a new infection takes place. Distribution in the storage house may also be brought about by the handling of potatoes when they are picked over and prepared for the market or by settling in the bins.

CAUSE OF BLACK ROT

Black rot is caused by a fungus (*Ceratostomella fimbriata*). It is a disease of the underground parts of the plant. Infection takes place through the roots, either coming from the soil after the plants are set in the field or by growing on the plants in the hotbed from diseased potatoes used for seed. Plants diseased so early in their life soon die, rarely producing any potatoes. This fungus, like many others of its kind, lives from one year to another on the dead vines or other decayed vegetable matter in the soil until it comes in contact with a sweet-potato plant.

FOOT ROT (DIE OFF)

Foot rot appears first as small brown to black spots on the stem of the plant near the soil line. Its growth at first is very slow, but eventually it girdles the plant and extends up the stem 4 or 5 inches. Soon thereafter wilting of the plant begins, and round, black, rather numerous specks, just visible to the naked eye, appear in the diseased areas. (Fig. 5.) These specks are the fruiting bodies of the fungus causing the disease. This disease progresses rather slowly, and it is about midsummer or later before the plants begin to die off. In most instances no potatoes are found in the affected hills, though long vines may have been produced.

The organism causing foot rot may spread from an infected stem to the roots and cause a brown, rather firm rot of the potato. Later, fruiting bodies standing close together develop on the surface in the form of pimplelike protuberances. (Fig. 6.) Many wounds and bruises on potatoes in storage are infected with the foot-rot fungus.

CONTROL OF FOOT ROT.

The same control measures should be employed for foot rot as for stem rot and black rot, namely, seed selection, the use of clean seed beds, and crop rotation.

DISTRIBUTION, PREVALENCE, AND LOSS

Foot rot is distributed in the same way as stem rot and black rot, through diseased soil, exchange of plants or seed potatoes, etc.

Foot rot is known to occur in Virginia, Maryland, Ohio, South Carolina, Iowa, California, and Missouri, and it is likely that it occurs elsewhere.

Owing to the fact that it is not so widely distributed, the total loss from this disease is much less than that due to black rot and stem rot. In localities where it does occur, however, it produces greater loss than either of those diseases. In certain parts of Virginia, Ohio, and Iowa it has been estimated to produce a loss of 50 per cent of the crop in one year.

FIG. 5.—Sweet-potato foot rot. The lower part of a sweet potato plant killed by the foot rot fungus

CAUSE OF FOOT ROT

To the fungus causing foot rot the name *Plenodomus destruens* has been given. Infection takes place primarily through the roots or underground parts of the plant, though during wet periods, when the growth is very luxuriant, diseased vines are sometimes found some distance from the hill. Infection takes place mostly in the hotbed by spreading from diseased potatoes to the plants. Such plants when set in the field usually die early in the season or at any rate seldom produce any potatoes. The growth of the fungus is very slow at first, and it is usually midsummer before field infections produce any marked injury. The organism advances along the stem to 4 or 5 inches above the soil line, turning the surface brown. About this time the vine wilts and the plant dies. In the diseased tissue

pimply domelike projections, just visible to the naked eye, can be seen scattered over the surface. The spores, borne in great numbers, escape from the projections and are carried by insects or other agencies to other plants, where new infections may result. If a diseased plant produces potatoes the fungus often grows down the roots and infects the potatoes. Here it may remain dormant during the storage period, but it will develop in the hotbed and infect the plants produced. As in the cases of stem rot and black rot, therefore, diseased seed potatoes give diseased plants, which in turn may produce diseased potatoes in the field. By this means the disease may be carried along with the crop indefinitely.

FIG. 6.—Sweet-potato foot rot. A sweet potato rotted by the foot-rot fungus. Note the fruiting bodies crowded together over the surface

SCURF (SOIL STAIN, RUST, JERSEY MARK)

DESCRIPTION

The scurf organism produces a brown discoloration of the surface of the underground parts of the sweet-potato plant. (Fig. 7.) The discolored areas may take the form of spots of different sizes and shapes with no definite outline, or there may be a uniform rusting of the entire surface of the potato. The fungus does not break the skin of the sweet potato and is so superficial as to be scraped off easily by the finger nail.

CONTROL OF SCURF

Probably the surest and safest way to control scurf is by the use of scurf-free seed. Other methods have been recommended, such as disinfecting the potatoes in a solution of corrosive sublimate or treating the soil with sulphur at the rate of 200 to 300 pounds to the acre. Both of these methods will doubtless effect partial control, but neither alone is as effective or practical as careful seed selection. It is advisable after selecting the seed to treat it in corrosive sublimate according to methods already outlined in order to destroy spores of this and other diseases that might be adhering to the surface of the potatoes.

Inasmuch as scurf will persist for a year or more in the soil, it is advisable to grow the plants in a seed bed made of sand obtained from some place where scurf is not likely to be present. The plants should be set in a field where the disease has not occurred for at least three years.

The scurf is worse on heavy soils and on soils containing a large quantity of organic matter, such as manure. It is likewise worse during a wet season and on low, wet ground. Such soils should be avoided.

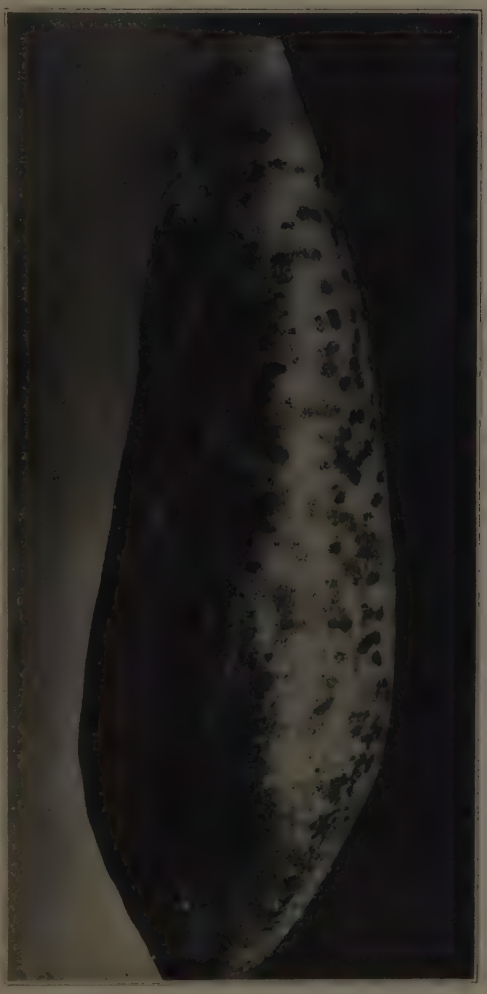


FIG. 7.—Sweet-potato scurf. A sweet potato showing discoloration caused by the scurf fungus

DISTRIBUTION, PREVALENCE, AND LOSS

Scurf is very common, having been found in Arkansas, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Ohio, Illinois, Iowa, Texas, and Kansas, and on practically all varieties.

The loss to the crop caused by scurf is perhaps small in comparison with some of the other more serious diseases; nevertheless, the actual financial loss throughout the country that can be attributed to this disease alone is considerable. Scurfy potatoes do not command as high a price in the market as clean ones, though if otherwise sound they are just as good for food. The scurf, under favorable conditions, such as a relatively high humidity and temperature, continues to develop under storage conditions to a limited degree. It weakens the sweet potato, so that during periods when the storage house is rather dry the potato loses moisture and becomes shriveled and dried.

CAUSE OF SCURF

Scurf is caused by a fungus (*Monilochaetes infuscans*). This organism lives through the winter on the potatoes in storage and on the decayed vines in the field. If infected potatoes are used for seed, the fungus grows on the plants and is carried by them to the field. The organism produces no apparent injury to the plants in the hotbed or in the field, but it continues its growth and follows down the roots to the potatoes. It will live for a considerable time on decayed vegetable matter in the soil in the absence of the sweet potato. Wet soils and soils containing a large quantity of organic matter are favorable to the disease. This fact has been recognized by many growers, and the disease is thought by them to be a stain caused by manure or organic matter.

FIG. 8.—Root rot. A sweet potato showing the characteristic shriveling produced by the root-rot fungus

ROOT ROT

DESCRIPTION

Root rot is best known as the Texas root rot of cotton and alfalfa. The organism causing it gains access to the plants on the underground parts and spreads in both directions, invading the vines for 6 to 12 inches above the ground. It may enter the end of the potato or cause spots of varying sizes on the surface. In either case a firm brown rot is produced, resulting in the complete destruction of the potato. (Fig. 8.) Above ground the growth is within the stem and may be detected by the brown discoloration produced. The organism lives from one season to the next in the soil on dead vegetable matter, or in the far South probably on growing winter crops. It is killed by hard freezing, and this alone probably restricts the disease to the Southern States.

CONTROL OF ROOT ROT

Root rot is worse on black, poorly drained soil and during wet seasons. The disease is particularly difficult to control or eradicate because it grows on a great variety of plants. Deep, clean cultivation, aeration of the soil, application of stable manure, and crop rotation, together with the careful selection of disease-free potatoes for seed, should be employed. Though the fungus attacks a great variety

of plants, both wild and cultivated, it has not been known to injure corn or any of the cereals, and these crops should be used in the rotation.

DISTRIBUTION, PREVALENCE, AND LOSS

Root rot occurs in Texas, New Mexico, Oklahoma, and Arizona. When the disease once gets into a field a whole crop may be destroyed. Large fields have been seen in which not more than 10 per cent of a crop was produced. Viewed from a distance, the field looked promising, but when harvested the potatoes were nearly all found to be destroyed by the fungus.

The disease may occasionally be observed as early as May or June, but it is in August that it becomes really serious. By this time the vines are well developed and the potatoes of considerable size. From this time on the disease increases in severity, so that by September and October, when the potatoes are dug, a large percentage of the crop may be found to be destroyed. It may occur in spots of various sizes. Not all hills and not all the potatoes in a hill are necessarily destroyed.

CAUSE OF ROOT ROT

Root rot is caused by a fungus (*Ozonium omnivorum*) which presumably lives from one season to the next by means of the brown hyphae and possibly spores. The mycelia or hyphae are produced on the surface of the roots in the form of grayish wefts or strands, which can be easily recognized with a hand lens by one familiar with the disease.

MOTTLE NECROSIS

DESCRIPTION

Mottle necrosis, a field disease of the enlarged roots, is characterized externally by brownish, somewhat sunken spots, which are noticeably irregular in shape and size. (Fig. 9.) Usually the potato is not softened but remains more or less firm. The most striking symptoms of the disease are revealed by cutting the potato crosswise through one of the brown, sunken surface spots. In cross section the disease is characterized by irregularly shaped patches of chocolate-brown dead tissue. (Fig. 10.) The dead patches frequently appear to have no connection with one another, giving in cross section a marbled appearance. The entire potato may be involved even though there is but a small spot of diseased tissue on the surface.

CONTROL OF MOTTLE NECROSIS

No method for the control of mottle necrosis has been worked out. The disease is worse some seasons than others, and is more prevalent during those seasons having an abundant rainfall and in soils that are fairly light and sandy, although some infection may occur in fairly heavy soils. The most susceptible varieties are Triumph, Yellow Jersey, Big Stem Jersey, and Georgia. Occasionally other varieties may be slightly infected.

In soil where this disease has occurred such varieties as those mentioned above should be avoided. Rotation with other crops every second or third year should be practiced.

FIG. 9. Mottle necrosis. A sweet potato showing a large portion of the surface brown and somewhat sunken. This condition is characteristic of the advanced stage of mottle necrosis

DISTRIBUTION, PREVALENCE, AND LOSS

Mottle necrosis occurs in New Jersey, Delaware, Virginia, North Carolina, and Mississippi and probably in other States. The loss varies from year to year, depending upon soil and weather conditions and on the variety grown. The entire loss throughout the country is relatively small, although in certain isolated districts, where such varieties as the Yellow Jersey are grown, losses as high as 40 per cent of the crop have occurred during seasons especially favorable for the disease.

CAUSE OF MOTTLE NECROSIS

Mottle necrosis is caused by two fungi (*Pythium ultimum* and *P. sclerotéichum*). The fungi probably gain entrance to the enlarged roots through the small fibrous roots attached to them. These small rootlets first become diseased and from them the large roots.

SOIL ROT (POX, GROUND ROT)

Soil rot produces symptoms markedly different from those caused by any other sweet-potato disease. In a badly infested soil the plants are dwarfed and often produce only one or two short vines. The leaves are small, thin, and pale green in color. The above-ground

symptoms are the result of injury to the root caused by an organism that may attack any part of the underground portion of the plant. The lateral feeding roots may be few in number and often more or less malformed. On the feeding roots, as well as on the underground part of the stem, occur somewhat black flecks or spots of various sizes and appearances. The decayed spots may occur on one side, or the root may be girdled, thereby cutting off the food supply. In the early stages of soil rot the lesions seem to be covered by the skin of the potato, which later ruptures, leaving conspicuous holes or pits. On the swollen roots (fig. 11) the pits often attain a diameter of one-half inch or more, with a jagged margin. The enlarged root is sometimes girdled, the potato continuing to enlarge on each side of the point of infection, thereby producing a curious disfiguration crudely resembling a dumbbell.

FIG. 10.—Mottle necrosis. A cross section through a sweet potato showing the characteristic mottling. The causal organism may enter through a small rootlet and ramify to all parts of the potato

FIG. 11.—Soil rot. A sweet potato showing typical soil-rot pits. The pits may be large or small and may occur on any of the underground parts of the plant

CONTROL OF SOIL ROT

No adequate control measure is known for soil rot. Some results of recent years indicate that the application of from 200 to 400 pounds of sulphur per acre will reduce the amount of soil rot and

increase the yield. The application of sulphur should be made with considerable care, as injury to the first and succeeding crops might result. The sulphur should be applied broadcast and thoroughly incorporated into the soil two to four weeks before setting out the crop.

Crop rotation and the improvement of the soil by the use of stable manure and green-manure crops can be recommended.

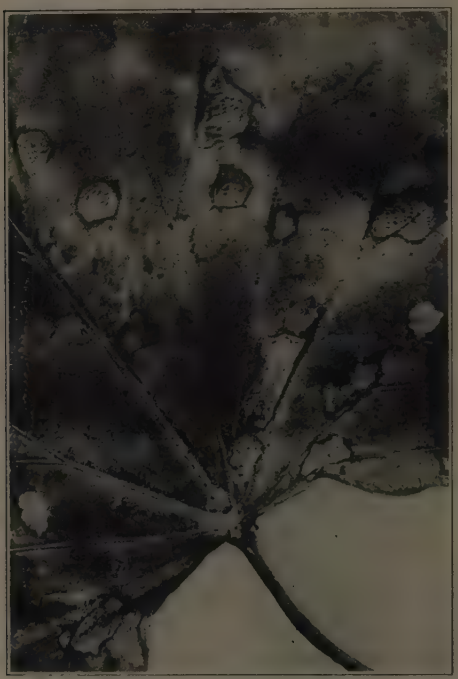


FIG. 12.—Section of a leaf of a sweet-potato plant showing the presence of a number of circular leaf-blight spots. Note the numerous black specks within the spots in which the spores are borne

DISTRIBUTION, PREVALENCE, AND LOSS

Soil rot occurs more or less generally throughout the sweet-potato belt. It occurs in California; in some, if not all, of the Southern States; in New Jersey, Delaware, Maryland, Virginia, Iowa, Kansas, and Illinois, and in practically all of the Northern States where sweet potatoes are grown. The disease does not occur generally distributed throughout a State but is more or less localized. It may be bad in one field or locality and absent in another only a few miles away.

While no figures can be given of the loss caused by soil rot, it may be estimated to be from practically nothing to almost complete failure. The losses appear to be worse during a dry season and on poor, impoverished soils.

CAUSE OF SOIL ROT

Soil rot is caused by an organism that lives in the soil from one season to the next. The principal source of infection is probably in the field, although it is not unlikely that infection may result from the use of infested soil in the hotbed and from infected seed potatoes.

LEAF BLIGHT

Leaf blight is caused by a fungus (*Phyllosticta batatas*). It appears on the upper side of the leaf as roundish or angular spots

one-eighth to one-half inch in diameter. (Fig. 12.) A number of black bodies about the size of a pin point and just visible to the naked eye are scattered indiscriminately within the spots. The bodies are slightly raised and rounded in a domelike manner and contain numerous colorless spores. So far as is known, the fungus is not parasitic on any other plant, neither does it occur on other parts of the plant than the leaf. It is thought to live through the winter on the dead leaves. The disease occurs every year in practically all the Southern States, but is less common as far north as New Jersey, Delaware, Maryland, Iowa, Kansas, and Illinois.

The Phyllosticta leaf blight has never been serious enough to require remedial measures.

FIG. 13.—Leaf spot. A leaf of a sweet-potato plant showing white spots caused by the leaf-spot fungus

LEAF SPOT

Leaf spot (*Septoria bataticola*), similar in general appearance to leaf blight, causes white spots about one-eighth inch in diameter, scattered indiscriminately over the upper surface of the foliage. (Fig. 13.) Within these white areas one or more black specks, just visible to the naked eye, may be seen. These specks contain numerous spores, which upon escaping may be carried by insects or other agencies to other leaves, where a new infection may start. Like the organism causing leaf blight, this fungus is not known to be parasitic on other plants or on other parts of the sweet potato. It probably winters over on the dead leaves in the field.

Leaf spot is very widely distributed, having been collected in New Jersey, Delaware, Iowa, and other States where sweet potatoes are grown. This disease is nowhere serious enough to require remedial measures.

WHITE RUST (LEAF MOLD)

The first symptom of white rust is characterized by a loss of the green color in indefinite spots on the under side of the leaf. (Fig. 14.) Later these spots become brown and covered with a whitish, viscid growth, which finally becomes more or less powdery. This white powdery mass is made up of numerous spores or reproductive bodies, which serve to start new infections if they fall on other leaves and conditions are favorable. No great amount of harm results

from the attack of this fungus, though it may sometimes produce swellings on the stems and petioles and cause malformations of the leaves. White rust is widely distributed and occurs on a number of other plants, among them the wild morning-glories. This disease has never been serious enough to require remedial measures.

White rust, caused by a fungus (*Albugo ipomoeae-panduranae*), is more prevalent during wet seasons. It is prevalent on sweet potatoes in the Tropics and commonly found in most of the Southern States. Under favorable weather conditions it occurs in New Jersey and other Northern States.

FIG. 14.—White rust. A leaf of a sweet-potato plant showing injury caused by the white rust fungus

STORAGE ROTS

SOFT ROT

Soft rot, caused by the bread mold (*Rhizopus nigricans*), is one of the most destructive diseases in the sweet-potato storage house. The decay begins usually at one end of the potato and progresses rapidly, requiring but a few days with favorable temperatures and humidity to destroy the entire potato. Soft rot may set in soon after the potatoes are stored, and it continues more or less throughout the storage period, depending largely upon the management of the house. The potatoes are first rendered soft, watery, and stringy. After decay and following the escape of moisture, the potatoes gradually become firm, hard, and brittle. Such dry potatoes are frequently referred to by the farmer as being affected with a dry rot, though in reality it is a dried soft rot. If the skin is broken while it is still soft a moldy growth forms on the surface. (Fig. 15.)

One soft-rot potato may communicate the disease to numerous potatoes lying close to it. The spores of the black mold produced on the surface may be carried by flies to other potatoes in the same house or may be communicated to them by handling. On these, new infections may take place if the temperature and moisture conditions are favorable.

RING ROT (COLLAR ROT)

Ring rot is caused by the same mold (*Rhizopus nigricans*) as soft rot. It differs from soft rot in that the decay begins at a point

between the two ends instead of at the ends. From the point of infection the decay forms a ring or collar around the potato, while at the same time it extends slowly toward the two ends. Under conditions favorable to the mold the potato may be wholly destroyed. If, on the other hand, conditions unfavorable for its further development exist, such as a relatively low humidity and low temperatures, it may develop no further than to form around the potato a ring or collar (fig. 16), varying in width from 1 inch to 2 or 3 inches.

The losses sustained in storage from soft rot and ring rot amount to many hundreds of thousands of dollars annually. The soft-rot organism is found everywhere and will grow on almost any decaying vegetable matter. It is, therefore, impossible to exclude it from storage houses. It generally gains an entrance to the potato through wounds and bruises made by rough handling.

FIG. 15. Soft rot. A sweet potato showing the moldy growth of the fungus causing soft rot

BLACK ROT

Black rot (*Ceratostomella fimbriata*), a serious disease of the plants in the hotbed and in the field, is a storage rot as well. The loss throughout the country caused by it in storage and in the field probably equals that of all the other diseases combined. When sweet potatoes are dug, black-rot spots are comparatively rare, but it is likely that many potatoes are infected, the point of infection being so small as to be invisible to the naked eye. In the storage house, in the presence of comparatively high temperatures and a relatively high humidity, these spots gradually enlarge, and at the end of a month or two they have formed conspicuous somewhat

round sunken spots on the surface of the potato. (Fig. 3.) Near the center of these spots are numerous flask-shaped fruiting bodies, from which exude myriads of small spores. These readily adhere to the bodies of insects and may be carried to other potatoes, where new infections may take place if sufficient moisture is present. The germs may also be scattered by workmen preparing potatoes for the market.

FIG. 16.—Ring rot. A sweet potato showing ring rot, frequently found in storage houses

DRY ROT

Dry rot is another form of decay which generally begins at the end of the potato, producing a firm brown rot. It grows slowly, the potato finally becoming dry, hard, and mummified. (Fig. 17.) Small domelike or pimplelike protuberances just visible to the naked eye finally cover the entire surface. If the skin is scraped slightly, the tissue beneath presents a coal-black, carbonaceous appearance. Several weeks are required under normal conditions for this organism to destroy a potato completely.

Dry rot is caused by a fungus (*Diaporthe batatatis*). In the little domelike protuberances (fig. 17) myriads of colorless spores are found which serve to reproduce the fungus. The dry-rot fungus grows on the stems and vines above ground under field conditions, and it is probably in the field that potatoes become infected. Dry rot has also been found on the stems of young plants in hotbeds.

Dry rot is widely distributed throughout the country and is frequently met with, but it can in no sense be regarded as one of the more serious storage troubles.

JAVA BLACK ROT

Java black rot, so called because its discovery on potatoes grown from an importation from Java suggested that the disease might have been introduced from that country, is widely distributed in storage houses, but is more prevalent in the South.

The disease, caused by a fungus (*Diplodia tubericola*), is strictly a storage trouble. It slowly renders the potatoes dry, hard, brittle, coal black within, and difficult to break. (Fig. 18.) It is reproduced by spores borne in more or less flask-shaped receptacles beneath the surface. When the surface of the potato is broken, these spore bodies are set free. The spores are at first colorless and one celled,

but they later turn dark and become two celled. The Java black rot begins usually at the end and progresses very slowly, requiring under normal storage conditions from four to eight weeks to destroy a potato completely.

CHARCOAL ROT

The charcoal rot, found in the storage houses throughout the country, likewise produces a black decay. This rot differs from

FIG. 17.—Dry rot. A sweet potato showing the characteristic appearance of dry rot. On the surface are domelike protuberances containing myriads of colorless spores which serve to reproduce the fungus

FIG. 18.—Java black rot. A sweet potato showing the dry, mummied condition produced by the fungus. Note the numerous pimplelike protuberances containing spores borne on the surface

others of a similar appearance by the production of minute spherical resting bodies throughout the potato, rarely on the surface. These bodies are coal black. If the skin of the potato is removed, these bodies can be seen with the naked eye buried in the tissue. Some shrinking and drying of the potato follow an invasion of this fungus.

The total loss to the crop that might be attributed to this disease is comparatively small. The rot is caused by the fungus *Sclerotium bataticola*.

CONTROL OF STORAGE ROTS

The United States could and would produce many more sweet potatoes if they could be marketed at a fair profit. One of the chief barriers to the extension of the industry is the inability of the farmers to keep the potatoes in storage so that they can be placed on the market in the winter, when prices are good. As a result most of the potatoes in the South are consumed locally or placed on the market at digging time, when prices are low. Consequently few sweet potatoes go on the northern markets in the winter, and even in the South where they are grown they can not be obtained with any degree of certainty at that season of the year. It is believed that if storage methods and principles were better understood more potatoes would be available for winter use and disposed of at a good price.

The success of the industry, however, does not depend on successful storage methods alone. There are several serious field diseases of the sweet potato, the best known of which are black rot, stem rot, and foot rot. The storage of black-rot potatoes must necessarily result in heavy loss, since the disease spreads rapidly throughout the bins. Stem rot, on the other hand, does not produce any marked decay in storage, but it may open the way for storage-rot organisms to enter the potato. It therefore becomes imperative that the elimination of the field diseases must supplement a well-regulated system of storage.

Great care should be exercised in handling sweet potatoes so as not to bruise them any more than necessary. The bruises made by rough handling and wounds such as those caused by mice and rats open the way for storage-rot organisms to enter. A farmer would never think of handling apples, oranges, or any of the fruits in the way that sweet potatoes are handled, yet a barrel of good sweet potatoes often will bring as much as, and frequently more than, a barrel of good apples, and sweet potatoes bruise even more readily than apples.

It is likely that if sweet potatoes were handled with the same care and intelligence as apples, and mice and rats kept out of the storage house, little difficulty would be experienced in keeping them.

After the potatoes are well dried in the field they should be carefully laid in an open crate holding about a bushel and hauled to the storage house. They should not be poured out of this crate into a bin, but stored in the crate itself. The use of crates permits the free circulation of air among the potatoes, a condition that can not be obtained if they are piled in a bin. The crate has an added advantage in that by its use as many potatoes can be taken out for the market during the winter as are desired without disturbing the remainder. Sweet potatoes will not stand frequent handling, and for that reason it is unwise to disturb a pile or a bin unless they are all marketed at the same time. The use of crates would eliminate this danger.

DIGGING AND HANDLING SWEET POTATOES

Sweet potatoes intended for storage should be dug as late in the fall as is consistent with weather conditions. This is usually just preceding frost. Frozen potatoes will not keep well, and it is likely that a heavy frost will injure them to some extent. It is advisable, too, after a heavy frost to cut the vines at once and dig. It is believed that warm, dry, sunny weather preceding a frost is better for all concerned than a period a little later in the season following a frost. To wait too long may mean that in order to avoid freezes the potatoes must be dug during bad weather. After digging, the potatoes should be allowed to dry as long in the sun as weather conditions and farm operations will permit. On a very hot day, however, it would be desirable to hurry the potatoes to the shade after their surfaces have been dried in the sun.

THE STORAGE HOUSE AND ITS MANAGEMENT

While sweet potatoes sometimes keep well when stored in banks with hay and earth thrown over them, this system is not as reliable as a storage house. For full details on storing and marketing sweet potatoes, the reader is referred to Farmers' Bulletin 970 of the United States Department of Agriculture. During the digging period and for 10 days or two weeks thereafter the temperature of the house should be maintained at about 80° to 85° F. This will assist in curing the potatoes and driving off surplus moisture. Ventilators should be so arranged and manipulated that the moisture given off by the potatoes will be carried out of the house. After about two weeks at a temperature of 80° to 85° the temperature should be lowered gradually to about 50° to 55° and maintained there through the storage period. During the winter the house should be watched as regards temperature and moisture. If any moisture is accumulating, it should be gotten rid of by opening the ventilators at the top and admitting dry air from below. This should be done on a dry day when the outside temperature is about the same as that of the storage house. The essentials in the management of the storage house are to keep it dry and maintain the temperature as near 50° to 55° as possible.

In the fall, just before the sweet potatoes are put into storage, the storage house or cellar should be disinfected thoroughly in order to destroy the numerous storage-rot germs left there from the previous crop. Any one of several efficacious methods may be employed. The house may be sprayed with a solution made by dissolving 1 pound of copper sulphate in 25 gallons of water, or with a solution of formaldehyde made by mixing 1 pint of formalin (40 per cent) in 30 gallons of water. In about 24 hours the house should be sprayed a second time. Similar results may be obtained by whitewashing the storage house or cellar, or, better yet, by making up a barrel of winter-strength lime-sulphur solution, 15 pounds of sulphur boiled until dissolved with 7½ pounds of stone lime and then the whitewash added to the mixture. A second coat of whitewash will not be necessary.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

October 29, 1928

Secretary of Agriculture	W. M. JARDINE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension	C. W. WARBURTON.
Director of Personnel and Business Administration	W. W. STOCKBERGER.
Director of Information	NELSON ANTRIM CRAWFORD.
Solicitor	R. W. WILLIAMS.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	C. L. MARLATT, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food, Drug, and Insecticide Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	E. W. ALLEN, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

This bulletin is a contribution from

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Vegetable and Forage Diseases	K. F. KELLERMAN, *Associate Chief of Bureau, in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
U.S.GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY